DESCRIPTION

STRETCHABLE RASCHEL-TYPE WARP KNIT FABRIC

TECHNICAL FIELD

The present invention relates to a stretchable raschel-type warp knit fabric.

BACKGROUND ART

Most of stretchable raschel-type warp knit fabrics, with an elastomeric fiber such as spandex laid therein, are of a satin net structure such as a four-course satin net, a six-course satin net or a ten-course satin net mixed with nylon fiber; a power net structure; a triconet structure; and a combined structure of elastomeric fiber and a net knitted by using two guide bar (thread guides). These stretchable raschel-type warp knit fabrics are mainly used for making a foundation garment such as a brasiere, a girdle or a body suit; and underwear such as shorts; pants or stretchable underwear. They are also used for making a swim suit, a spat, a leotard and cycling pants, and they can be used for making a jumper or a top after being laminated or coated.

There is a problem, however, in the stretchable raschel-type warp knit fabric, wherein nylon fiber is used for forming a ground structure, in that the yellowing inherent to the nylon fiber, which occurs due to the heat setting during the dyeing or finishing of the fabric, or the influence of NOX gas while the fabric is stocked, has not yet been solved. At present, to avoid yellowing, the dyeing is carried out at a low temperature or the finished goods is stored in a completely sealed package. Such countermeasures are, however, problematic because the stretchability is lowered and the procedure for product delivery becomes extremely troublesome.

There has been an attempt to produce a stretchable raschel-type warp knit fabric composed of polyethylene terephthalate fiber practically free from the yellowing

and elastomeric fiber however, while the problem of yellowing could be solved, the knit fabric became harder to deteriorate a soft touch necessary for a foundation garment, which touch could be obtained if nylon fiber was used instead of the polyethylene terephthalate fiber. For this reason, the stretchable warp knit fabric containing polyethylene terephthalate fiber has hardly been used for making foundation garments requiring a soft touch because they are worn in contact with a human skin.

Also, a girdle or a body suit made from the stretchable raschel-type warp knit fabric composed of polyethylene terephthalate fiber combined with elastomeric fiber laid in, is liable to have several drawbacks including "grinning" (a phenomenon in that after being stretched, the fabric cannot be immediately recovered to the original state) which appears when excessive stretching is applied thereto upon putting-on or off or after stretching/shrinking has been repeated during use on a human body. Particularly, the knit fabric containing polyethylene terephthalate fiber must be knitted under a low knitting tension to cause the touch of the finished fabric to be as soft as possible, which in turn is liable to induce the grinning defect, whereby the stretchable raschel-type warp knit fabric could be produced solely under extremely limited conditions.

DISCLOSURE OF THE INVENTION

An object of the present invention is to solve the above-mentioned problems of the stretchable raschel-type warp knit fabric into which elastomeric fiber is insert-knit and provide a stretchable raschel-type warp knit fabric free from yellowing, having soft touch and being free from the grinning.

Such an object of the present invention is achievable by a stretchable raschel-type warp knit fabric formed of a ground structure of polytrimethylene terephthalate fiber combined with elastomeric fiber laid

in, wherein the knit fabric has a number of courses in a range from 100 to 200 courses per 2.54 cm, and a product of the number of courses and the number of wales per 2.54 cm is in a range from 4,000 to 8,000.

According to the present invention, the fiber forming the ground structure is polytrimethylene terephthalate fiber composed of trimethylene terephthalate units of approximately 50 mol% or more, preferably 70 mol% or more, more preferably 80 mol% or more, most preferably 90 mol% or more, and a third component; i.e., another acidic and/or glycolic component described later; of approximately 50 mol% or less, preferably 30 mol% or less, more preferably 20 mol% or less, most preferably 10 mol% or less.

The polytrimethylene terephthalate fiber used in the present invention may be prepared by a method wherein, after an undrawn yarn has been obtained at a takeup speed of approximately 1,500 m/min, it is drawn at a draw ratio in a range from approximately 2 to 3.5 times or a spin-draw method, wherein a spinning process is directly combined with a drawing process or a spin-takeup method wherein a yarn spun from a spinning machine is directly taken up at a high speed of 5,000 m/min or more.

The polytrimethylene terephthalate fiber may be a continuous filament or staple fiber, including those uniform or irregular in fineness in the lengthwise direction, with a cross-sectional shape which may be circular, triangular, polygonal, multi-lobal or indefinite, including an L-shape, a T-shape, a Y-shape, a W-shape, an octagonal lobal shape, a flat shape and a dog-bone shape. The fiber may be either solid or hollow. The fiber may be converted to a yarn form such as a spun yarn manufactured on a ring spinning frame or an open end spinning frame, a filament yarn having a filament fineness in a range from 0.1 to 5.6 dtex (including an ultra-fine yarn), a soft or hard twisted yarn, a mixed fiber yarn, a false-twist textured yarn (including a

draw-false twist textured yarn of POY) or an air jet textured yarn.

In this regard, the polytrimethylene terephthalate fiber may be mixed with natural fiber represented by wool generally in an amount of 30% or less by weight, unless the resultant yarn is contradictory to the object of the present invention, through a fiber-mixing means, such as a mixed-spinning process (including CIRO-spun or CIRO-fil), an entanglement mixing process (wherein yarns having various shrinkages are mixed together), a mixed-twisting process, a composite false-twist process (including an elongation-difference false-twist process) or a two-feed air jet texturing process.

The elastomeric fiber used in the present invention is spandex fiber having a good elasticity, such as that of a polyurethane type or a polyether/ester type, wherein kinds of polymer and/or spinning methods for obtaining the same are not limited. Preferably, the elastomer fiber has an elongation at break in a range from 100% to 1,000% and the stretchability thereof is not lowered even at a high temperature of approximately 180°C which is usually adopted in a presetting process of the dyeing operation. A fineness of the elastomeric fiber is preferably in a range from 30 to 780 dtex, and should be selected in accordance with structures of the knit fabric. For example, in a six-course satin net, the fiber fineness is selected from a range from 220 to 560 dtex,; in a power net, from 220 to 560 dtex; in a triconet, from 78 to 560 dtex; and in a net knitted by using two thread guides for elastomeric yarns, from 78 to 560 dtex for a back thread guide No. 1 and from 30 to 78 dtex for a back thread guide No. 2.

While the elastomeric fiber may be either a bare yarn or a covered yarn of a polyurethane type elastomeric fiber, the bare yarn is preferable in view of the ease of warping or the improvement in stretchability of the knit fabric.

Examples of a knit structure of the stretchable raschel-type warp knit fabric according to the present invention are a satin net structure (which may be called a satin structure) such as a four-course satin net, a six-course satin net or a ten-course satin net, a power net structure, a triconet structure and a combined structure of a net and elastomeric fibers fed through two thread guides. The satin net structure is preferably used because it is rich in luster and excellent in stretchability as well as being usable for general purposes.

Preferably, the elastomeric fiber is basically laid in the knit structure. A loop structure of the knit fabric may be either an open loop, a closed loop or any combination thereof.

Polytrimethylene terephthalate fiber may be fed through two thread guides to form a ground structure, and elastomeric fiber may be laid in through two thread guides, but the knit structure should not be limited thereto.

A preferable example of the satin net structure is a six-course satin net represented by the following examples. Polytrimethylene terephthalate fiber is threaded to a front thread guide for knitting the satin net structure and elastomeric fiber is threaded to a back thread guide. In some cases, a knit structure knitted by the front thread guide is positionally shifted to a knit structure knitted by the back thread guide (see Example 2 below).

(Example 1 of six-course satin net structure)

Front: 20/02/20/24/42/24 (all in)

Back : 00/44/22/66/22/44 (all in)

(Example 2 of six-course satin net structure)

Front: 20/02/20/24/42/24 (all in)

Back : 22/44/00/44/22/66 (all in)

(Example of power net structure)

Front 1: 20/24/42/46/42/24 (1 in, 1 out)
Front 2: 46/42/24/20/24/42 (1 in, 1 out)
Back 1 : 22/00 (1 in, 1 out)
Back 2 : 00/22 (1 in, 1 out)

(Example of triconet structure)

Front 1: 46/44/20/22 (all in)
Front 2: 22/24/22/20 (all in)
Back : 22/44/22/00 (all in)

(Example of combined structure of elastomeric fibers through two thread guides and a net)

Front: 24/42/46/42/24/20 (all in)
Back 1: 00/22 (all in)
Back 2: 44/66/00/22/00/66 (all in)

According to the present invention, to obtain, irrespective of the kind of the knit structure, a dyed and finished raschel-type warp knit fabric soft in touch and free from grinning during the use, it is important that the number of courses per 2.54 cm of the finished knit fabric is in a range from 100 to 170, preferably from 120 to 170, and a product of the number of courses per 2.54 cm and the number of wales per 2.54 cm is in a range from 4,000 to 8,000.

Even though the polytrimethylene terephthalate fiber which is soft in touch is used for obtaining the ground structure, if the knit density is too high in the finished fabric, the resultant knit fabric has a hard touch and also the basis weight or the thickness thereof becomes larger because of a stretchability inherent to the material. As the knit density becomes lower, the resultant fabric is softer in touch, smaller in thickness and lighter in basis of weight. However, the lower the knit density, the smaller the constraint to the elastomeric fiber by the polytrimethylene fiber, whereby the generation of grinning in the knit fabric becomes conspicuous. To obtain a stretchable raschel-type warp knit fabric soft in touch and free from grinning, it is

indispensable to select the number of courses and the product of the numbers of courses and wales in the above-mentioned range.

If a fabric density in the warp direction is less than 100 courses/2.54 cm, the surface appearance of the raschel-type warp knit fabric becomes worse, and a burst strength thereof is extremely lowered. Contrarily, while the surface appearance and the burst strength are improved if the fabric density in the warp direction is more than 200 courses/2.54 cm, the touch becomes hard because the basis of weight and the thickness of the fabric are too large.

While the fabric density in the warp direction is an important factor in the stretchable raschel-type warp knit fabric of the present invention as described above, a total fabric density; i.e., a product of the number of courses/ 2.54 cm and the number of wales/ 2.54 cm (hereinafter referred to a "product density"); is another important factor. It is necessary that the product density is in a range from 4,000 to 8,000, preferably from 4,500 to 7,000, more preferably from 5,000 to 6,500. If the product density is less than 4,000, the touch becomes soft. However, the surface appearance becomes worse and grinning is liable to occur due to the loosening of knit structure. In addition, the burst strength lowers to an extreme extent. On the other hand, if the product density exceeds 8,000, the knit fabric has a satisfactory burst strength and is free from the generation of grinning. However, such a fabric is unsuitable for foundation wear use because the touch thereof is hard.

Accordingly, it is necessary to prepare a grey knit fabric so that the above-mentioned ranges of the number of courses and the product of the numbers of courses and wales are obtained in the finished stretchable raschel-type warp knit fabric while taking the fabric shrinkage, or other factors, into account.

Although there are no limitations in the kind and the needle gauge of the raschel machine for preparing the stretchable raschel-type warp knit fabric, a single raschel machine having a needle gauge in a range from 48 to 64 needles/5.08 cm (from 24 to 32 needles/2.54 cm) is preferably used.

To obtain a grey fabric favorably used for the present invention, it is necessary to knit the same while increasing a runner length of yarns to more than in a mixed fiber knit fabric composed of nylon fiber or polyethylene terephthalate fiber and elastomeric fiber and decreasing the number of courses on the machine. The runner length of the trimethylene terephthalate fiber and the elastomeric fiber and the number of courses on the machine should be selected so that the predetermined knit density is achieved in the final fabric obtained by scouring the grey fabric, presetting it under tension in the width direction before dyeing to have substantially the same width and length as those of the dyed fabric, and dyeing and finishing it. The setting may be carried out under known condition such as at a temperature in a range from 150 to 200°C for a time in a range from 30 to 60 seconds. The presetting process is preferably carried out at approximately 190°C, and the final setting process is preferably carried out at approximately 170°C, so that the setting and the color fastness are improved. In this regard, a liquid stream type dyeing machine is preferably used for carrying out the dyeing of the stretchable raschel-type warp knit fabric because of the increased breaking or mellowing effect applied to the latter.

The explanation will be made of a knit fabric of a six-course satin net structure. First, the number of courses on the machine is set at a lower level, preferably in a range from 65 to 85 courses/2.54 cm, and a grey fabric is knitted under a proper knitting tension. More specifically, the grey fabric is preferably knitted by combining a runner length of a front yarn in a range

from 1,250 to 1,350 mm/rack (1 rack: a yarn length necessary for knitting 480 courses) with a runner length of a back yarn in a range from 120 to 165 mm/rack and by adjusting a product of the runner lengths of front and back yarns in a range from 150,000 to 215,000. According to the grey fabric thus obtained, the fabric density is easily adjustable when the fabric is finished. If the product of the runner lengths of front and back yarns is selected to be 150,000 or less, the course density or the fabric density is liable to increase whereby the finished fabric has a harder touch or a smaller elongation. Contrarily, if the product is 215,000 or more, the knitting tension becomes excessively low whereby the fabric structure becomes unstable even in the grey fabric to cause grinning in the finished fabric. Then, in the dyeing and finishing process, the grey fabric is widened in the presetting step after the scouring so that the product density is, for example, in a range from 3,500 to 6,000. Finally, the fabric is dyed and finished so that the length and the width are kept unchanged between before and after the dyeing (i.e., the number of courses and the number of wales are kept unchanged). The knit fabric of such a design has the predetermined knit density and is free from problems in fabric shrinkage such as laundering shrinkage and pressing shrinkage. The setting step is carried out at a temperature in a range from 150 to 200°C, preferably at 190°C when preset and at 170°C when finally set, to result in the warp knit fabric being easily settable and free from drawbacks in color fastness.

The polytrimethylene terephthalate forming the polytrimethylene terephthalate fiber used for the stretchable raschel-type warp knit fabric according to the present invention is synthesized by combining terephthalic acid or functional derivative thereof and trimethylene glycol or functional derivative thereof in the presence of a catalyst and under suitable reactive

conditions. During this synthesizing process, one kind or more of suitable third components are added to obtain a copolymerized polyester. Otherwise, after a polyester other than polytrimethylene terephthalate, such as polyethylene terephthalate or nylon, has been synthesized separately from polytrimethylene terephthalate, they are blended with each other or compositely spun (to obtain a sheath-core type yarn or a side-by-side type yarn).

The third component to be added when the polytrimethylene terephthalate is synthesized includes an aliphatic dicarbonic acid (oxalic acid, adipic acid or the like), a cycloaliphatic dicarbonic acid (cyclohexane dicarbonic acid or the like), an aromatic dicarbonic acid (isophthalic acid, sodium sulfoisophthalic acid or the like), an aliphatic glycol, (ethylene glycol, tetramethylene glycol, 1, 2-propylene glycol, tetramethylene glycol or the like), a cycloaliphatic glycol (cyclohexane dimethanol or the like), an aliphatic glycol containing aromatic group (1, 4-bis(β-hydoxyethoxy) benzene or the like), a polyether glycol (polyethylene glycol, polypropylene glycol or the like), an aliphatic oxycarbonic acid (ω-oxycapronic acid or the like) or an aromatic oxycarbonic acid (P-oxybenzoic acid or the like). Also, compounds having one or three or more ester-forming functional groups (benzoic acid, glycerin or the like) may be used provided the polymer is maintained substantially in a linear range.

The polytrimethylene terephthalate may contain, by adding during the spinning, a delustering agent such as titanium dioxide, a stabilizing agent such as phosphoric acid, an ultraviolet absorbing agent such as derivative of hydroxybenzophenone, a crystal neucleator, such as talc, a lubricant such as aerozil, an antioxidant such as derivative of hindered phenol, a flame retardant, an antistatic agent, a pigment, a fluorescent whitener, an infrared absorbing agent, and an antifoaming agent.

BEST MODES FOR CARRYING OUT THE INVENTION

The present invention will be described in more detail below with reference to the preferred embodiments, but should not be limited thereto.

The preparation of polytrimethylene terephthalate fiber used in examples, a method for measuring a fineness of elastomeric fiber and the estimation of a raschel-type warp knit fabric are carried out as described below:

(1) Preparation of polytrimethylene terephthalate fiber

Polytrimethylene terephthalate of $\eta sp/c = 0.8$ is spun at a spinning temperature of 265°C and at a spinning speed of 1,200 m/min to become an undrawn yarn. Then, the undrawn yarn is drawn at a hot roll temperature of 60°C, a hot plate temperature of 140°C, a draw ratio of three times and a drawing speed of 800 m/min to become drawn yarns of 40 dtex/24f, 56 dtex/36f, 84 dtex/48f or other sizes. For example, a strength, an elongation, an initial tensile resistance (Young's modulus) and an elastic recovery at 10% elongation are 2.8 cN/dtex, 46%, 27 cN/dtex and 98%, respectively.

The elastic recovery at 10% elongation of the polytrimethylene terephthalate fiber is measured in such a manner that the fiber is attached to a tensile tester, so that a grip length is 10 cm, and is stretched by 10% at a speed of 20 cm/min, and is left as it is for 1 minute. Thereafter, the fiber is made to shrink at the same speed as before so that a stress-strain curve is obtained. An elongation (A: a residual elongation) is obtained on the curve at a point where the stress becomes zero and the elastic recovery is calculated by the following equation:

$$\text{Elastic recovery at 10\% elongation} = (10 - A) / 100 \ (\%)$$

The viscosity $\eta sp/c$ of polytrimethylene

terephthalate polymer is measured in such a manner that the polymer is dissolved in o-chlorophenol at a concentration of 1 g/dl, and the solution thus obtained is transferred to an Ostwald viscometer and measured at 35°C. The viscosity is determined by the following equation

$$\eta sp/c = (T/To - 1) / C$$

wherein T is a time required for dropping the sample solution (seconds), To is a time required for dropping the solvent, and C is a concentration of solution (g/dl).

(2) Measurement of fineness of elastomeric fiber

The fineness of the elastomeric fiber is measured as follows:

The elastomeric fiber is relaxed under a condition at 20°C and 65% RH while being stationarily placed on a desk, with no load, in a tensionless state. Thereafter, samples of 1,000 mm long are prepared therefrom, and ten of them are weighed together. The measured value is converted to a weight of the fiber of 10,000 m long; that is, a dtex value.

(3) Evaluation of stretchable raschel-type warp knit fabric

[1] Evaluation of touch

A degree of softness is evaluated in accordance with a JIS-L-1096 Method A for the measurement of hardness and softness (a 45-degree cantilever method), except for changing a size of a test piece to 25 mm X 150 mm.

The degree of softness is calculated by equation (2). If the value thus obtained is less than 125 mm, it is determined that the sample has a soft touch, while if the value is 125 mm or more, it is determined that the sample has a hard touch.

Degree of softness = moving length of normally placed warp-directional test piece + moving length of reversely placed warp-directional test piece + moving length of normally placed transverse-directional test piece + moving length of reversely placed transverse-

directional test piece--- (2)

[2] Evaluation of grinning defect

Two pieces of the stretchable raschel-type warp knit fabric of a 100 mm X 90 mm size in the warp direction and the transverse direction, respectively, are cut from the original fabric. Each of the pieces is folded so that the length thereof is half in the warp direction and opposite edges thereof, superposed to each other, are sewn together by means of a two-needle type overlock sewing machine with a margin to seam of 7 mm. The sewing thread used is a wooly nylon of 235 dtex, the sewing pitch is 13 stitches/2.54 cm, and the needle used is of a ball point type #11. A test piece thus obtained is sufficiently immersed into an aqueous solution of weak alkaline synthetic detergent, and then fixed to an elongation fatigue tester (available from Takemoto Systems; Dematcher tester) so that the seam is located at a center at a grip length of 70 mm. The test piece is stretched and relaxed at a predetermined stroke (described later) and a speed of 200 cycles/min so that the elongation and relaxation are repeated 10,000 for cycles. After being removed from the tester, the test piece is observed for the surface and profile appearance, the disturbance of fabric structure and breakage of elastomeric fiber. The determination is made on the basis of the following criteria:

Grade 5: Change is hardly observed in the test piece before and after the elongation fatigue test.

Grade 4: A width of the test piece is somewhat smaller and the appearance is slightly worse.

Grade 3: A width of the test piece is somewhat smaller and the appearance is somewhat worse.

Grade 2: A width of the test piece is clearly smaller, the appearance is worse and the disturbance of structure occurs.

Grade 1: A width of the test piece is clearly

smaller, the appearance is worse and the disturbance of structure as well as the breakage of elastomeric fiber occurs. Unsuitable for commercial goods.

When tested by the elongation fatigue tester, an amount of elongation of test piece is measured in the following manner:

A test piece, 200 mm long in the warp direction and 25.4 mm long in the transverse direction, is prepared from the stretchable raschel-type warp knit fabric, and is attached to a Tensilon tensile tester. A tensile test is carried out at an initial load of 4.9 cN, a grip length of 100 mm and a stretching speed of 300 mm/min, and elongations at loads of 9.8 N and 14.7 N are measured, from which the amount of elongation is determined by the following equation (3):

Amount of elongation (%) = [(elongation at 9.8 N load) + (elongation at 14.7 N load)] / 2 --- (3)

[3] Yellowing

The yellowing is measured in accordance with a JIS-L-0855 method for color fastness to nitric oxide gas; a weak test.

[4] Measurement of transverse elongation

A test piece, 25.4 mm long in the warp direction and 200 mm long in the transverse direction, is prepared from the stretchable raschel-type warp knit fabric, and stretched by a Tensilon tensile tester under the condition of an initial load of 4.9 cN, a grip length of 100 mm and a stretching speed of 300 mm/min until the load reaches 14.7 N, at which elongation is measured.

[5] Evaluation of heat-moldability

A mold of 60 mm diameter and 75 mm height is applied under pressure onto the stretchable raschel-type warp knit fabric by means of a draw mold machine (available from Daido Company) to cause the plastic deformation in the knit fabric. The molded state of the deformed knit fabric is estimated in accordance with the following

criteria. In this regard, the mold having a constant temperature of 180°C is pressed onto the test piece having a size of 30 cm X 30 cm for 30 seconds so that a molding depth of 20 mm is obtained.

○: the test piece has a molded shape of 18 cm or more, and the touch thereof is unchanged.

×: the test piece has a molded shape of less than 18 cm, or the touch thereof is changed.

Example 1

A six-course satin net was knit from polytrimethylene fiber of 56 dtex/36f used as a warp yarn for a front thread guide and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 310 dtex used as a warp yarn for a back thread guide while drafted at a ratio of 80%, under the following condition:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 28 needles/2.54 cm)

Knit structure: front 20/02/20/24/42/24
back 00/44/22/66/22/44

Runner length: front 1270 mm, back 155 mm

Number of courses on machine: 80 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 150 courses/2.54 cm X 32 wales/2.54 cm, after which the fabric was dyed in a liquid stream type dyeing machine. Thereafter, a final set was carried out to maintain a length and width of the dyed fabric as they are, whereby the stretchable raschel-type warp knit fabric was obtained. The evaluation results of the stretchable raschel-type warp knit are shown in Table 1.

As is apparent from Table 1, the finished

stretchable raschel-type warp knit fabric has a basis of weight of 206 g/m^2 and a thickness of 0.53 mm, is free from yellowing and is soft in touch as well as being free from grinning. Further, this fabric is excellent in transverse elongation and the heat-moldability, in comparison with the conventional product and, therefore, most suitable for foundation wear use.

Examples 2 and 3

The same grey fabric as prepared in Example 1 was preset to have different fabric densities and was finished in accordance therewith. Test pieces were prepared and tested. The results are shown in Table 1.

As is apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning. Further, this fabric is excellent in transverse elongation and the heat-moldability in comparison with the conventional product and, therefore, most suitable for foundation wear use.

Examples 4 to 7

Test pieces were prepared in the same manner as in Example 1 except for changing the runner length to various sizes. The estimated results are shown in Table 1.

As apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning. Further this fabric is excellent in transverse elongation and heat-moldability in comparison with the conventional product, and therefore most suitable for foundation wear use.

Example 8

Test pieces were prepared in the same manner as in Example 1 except for changing the polyurethane type

elastomeric fiber used as a back warp yarn to a covering yarn (available from Asahi Kasei Kogyo K.K.; prepared by single-covering Loica of 230 dtex with cotton of 74 dtex). The evaluation results were shown in Table 1.

As is apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning. Further this fabric is excellent in the transverse elongation and the heat-moldability in comparison with the conventional product, and therefore most suitable for foundation wear use.

Example 9

A six-course satin net was knitted from polytrimethylene fiber of 56 dtex/36f used as a warp yarn for a front thread guide and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 310 dtex used as a warp yarn for a back thread guide while drafted at a ratio of 80%, under the following condition:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 24 needles/2.54 cm)

Knit structure: front 20/02/20/24/42/24
back 00/44/22/66/22/44

Runner length: front 1310 mm, back 125 mm

Number of courses on machine: 70 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 140 courses/2.54 cm X 30 wales/2.54 cm, after which the fabric was dyed in a liquid-stream-type dyeing machine. Thereafter, a final set was carried out to maintain a length and width of the dyed fabric as they are, whereby the stretchable raschel-type warp knit fabric having a basis of weight of 185 g/m^2 and a thickness of 0.50 mm was obtained. The results of evaluation of the stretchable raschel-type warp knit is shown in Table 1.

As apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and soft in touch as well as free from grinning. Further this fabric is excellent in the transverse elongation and the heat-moldability in comparison with the conventional product, and therefore most suitable for foundation wear use.

Example 10

A six-course satin net was knitted from polytrimethylene fiber of 40 dtex/24f used as a warp yarn for a front thread guide and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 310 dtex used as a warp yarn for a back thread guide while drafted at a ratio of 80%, under the following conditions:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 28 needles/2.54 cm)

Knit structure: front 20/02/20/24/42/24
back 00/44/22/66/22/44

Runner length: front 1270 mm, back 155 mm

Number of courses on machine: 80 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 150 courses/2.54 cm X 30 wales/2.54 cm, after which the fabric was dyed in a liquid stream type dyeing machine. Thereafter, a final set was carried out to maintain a length and a width of the dyed fabric as they are, whereby the stretchable raschel-type warp knit fabric having a basis of weight of 191 g/m^2 and a thickness of 0.48 mm was obtained. The results evaluation of the stretchable raschel-type warp knit are shown in Table 1.

As is apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning. Further, this fabric is

excellent in the transverse elongation and the heat-moldability in comparison with the conventional product and, therefore most suitable for foundation wear use.

Example 11

A six-course satin net was knitted from polytrimethylene fiber of 84 dtex/48f used as a warp yarn for a front thread guide and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 310 dtex used as a warp yarn for a back thread guide while drafted at a ratio of 80%, under the following conditions:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 28 needles/2.54 cm)

Knit structure: front 20/02/20/24/42/24
back 00/44/22/66/22/44

Runner length: front 1270 mm, back 155 mm

Number of courses on machine: 80 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 150 courses/2.54 cm X 30 wales/2.54 cm, after which the fabric was dyed in a liquid stream type dyeing machine. Thereafter, a final set was carried out to maintain a length and width of the dyed fabric as they are, whereby the stretchable raschel-type warp knit fabric having a basis of weight of 232 g/m^2 and a thickness of 0.54 mm was obtained. The results evaluation of the stretchable raschel-type warp knit are shown in Table 1.

As is apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning. Further this fabric is excellent in transverse elongation and heat-moldability in comparison with the conventional product, and therefore is most suitable for foundation wear use.

Example 12

A power net was knit from polytrimethylene fiber of 56 dtex/36f used as a warp yarn for front thread guides Nos. 1 and 2 and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 78 dtex used as a warp yarn for back thread guides Nos. 1 and 2 while drafted at a ratio of 80%, under the following conditions:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 28 needles/2.54 cm)

Knit structure: front No. 1; 20/24/42/46/42/24 (1 in 1 out)
front No. 2; 46/42/24/20/24/42 (1 in 1 out)
back No. 1; 22/00 (1 in 1 out)
back No. 2; 00/22 (1 in 1 out)

Runner length: front Nos. 1 and 2; 950 mm, back Nos. 1 and 2; 90 mm

Number of courses on machine: 80 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 180 courses/2.54 cm X 30 wales/2.54 cm, after which the fabric was dyed in a liquid stream type dyeing machine. Thereafter, a final set was carried out to maintain a length and width of the dyed fabric as they are, whereby the stretchable raschel-type warp knit fabric having a basis of weight of 163 g/m^2 and a thickness of 0.42 mm was obtained. The evaluation results of the stretchable raschel-type warp knit are shown in Table 1.

As is apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning, and therefore is most suitable for foundation wear use.

Example 13

A triconet was knitted from polytrimethylene fiber of 56 dtex/36f used as a warp yarn for a front thread guide No. 1, that of 40 dtex/24f used as a warp yarn for a front thread guide No. 2 and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 78 dtex used as a warp yarn for a back thread guide while drafted at a ratio of 80%, under the following conditions:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 28 needles/2.54 cm)

Knit structure: front No. 1; 46/44/20/22 (all in)
front No. 2; 22/24/22/20 (all in)
back ; 22/44/22/00 (all in)

Runner length: front No. 1; 850 mm, front No. 2; 380 mm, back; 70 mm

Number of courses on machine: 85 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 156 courses/2.54 cm X 30 wales/2.54 cm, after which the fabric was dyed in a liquid stream type dyeing machine. Thereafter, a final set was carried out to maintain a length and width of the dyed fabric as they are, whereby the stretchable raschel-type warp knit fabric having a basis of weight of 161 g/m^2 and a thickness of 0.44 mm was obtained. The results evaluation of the stretchable raschel-type warp knit are shown in Table 1.

As is apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning, and therefore is most suitable for foundation wear use.

Example 14

A knit fabric of a combination of a two-thread guide elastomeric fiber structure and a net was knitted from polytrimethylene terephthalate fiber of 56 dtex/36f used

as a warp yarn of a front thread guide and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 155 dtex and 44 dtex used as a warp yarn of back thread guides Nos. 1 and 2, respectively, while drafted at a ratio of 80%, under the following condition:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 28 needles/2.54 cm)

Knit structure: front; 24/42/46/42/24/20 (all in)
back No. 1; 00/22 (all in)
back No. 2; 44/66/00/22/00/66 (all in)

Runner length: front; 1145 mm, back No. 1; 120 mm, back No. 2; 180 mm

Number of courses on machine: 80 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 150 courses/2.54 cm X 40 wales/2.54 cm, after which the fabric was dyed in a liquid stream type dyeing machine. Thereafter, a final set was carried out to maintain a length and width of the dyed fabric as they are, whereby the stretchable raschel-type warp knit fabric having a basis of weight of 226 g/m^2 and a thickness of 0.54 mm was obtained. The results evaluation of the stretchable raschel-type warp knit are shown in Table 1.

As apparent from Table 1, the stretchable raschel-type warp knit fabric according to the present invention is free from yellowing and is soft in touch as well as being free from grinning, and therefore is most suitable for foundation wear use.

Comparative examples 1 to 4

The same grey fabric as prepared in Example 1 was preset to have different fabric densities and finished in accordance therewith, from which test pieces were prepared. The results of evaluation are shown in Table 2.

As apparent from Table 2, the stretchable raschel-

type warp knit fabric obtained from the above Comparative examples is free from yellowing but unsatisfactory in view of either softness or grinning, and therefore is unsuitable for foundation wear use.

Comparative example 5

A stretchable raschel-type warp knit fabric was prepared in the same manner as in Example 1 except that polyamide 6 fiber of 56 dtex/36f is used as a warp yarn for a front thread guide. The evaluation results are shown in Table 2. As is apparent from Table 2, the stretchable raschel-type warp knit fabric obtained from the above Comparative example is unsatisfactory due to the generation of yellowing and grinning, and therefore is unsuitable for foundation wear use.

Comparative example 6

A six-course satin net was knitted from polyamide 6 fiber of 56 dtex/36f used as a warp yarn for a front thread guide and polyurethane type elastomeric fiber (available from Asahi Kasei Kogyo K.K.; a trade name: Loica) of 310 dtex used as a warp yarn for a back thread guide while drafted at a ratio of 80%, under the following conditions:

Knitting machine: a single raschel loom (available from Karl Mayer, Type RSE4N, gauge: 28 needles/2.54 cm)

Knit structure: front 20/02/20/24/42/24
back 00/44/22/66/22/44

Runner length: front 1135 mm, back 98 mm

Number of courses on machine: 91 courses/2.54 cm

The grey fabric was scoured and preset at a temperature of 190°C for 45 seconds. A fabric density was set at 174 courses/2.54 cm X 40 wales/2.54 cm, after which the fabric was dyed in a liquid stream type dyeing machine. Thereafter, a final set was carried out to maintain a length and width of the dyed fabric as they are, whereby a stretchable raschel-type warp knit fabric

corresponding to the prior art fabric was obtained, which has a basis of weight of 189 g/m^2 and a thickness of 0.50 mm. The evaluation results of the stretchable raschel-type warp knit are shown in Table 2. As is apparent from Table 2, this fabric is free from the generation of grinning, but problematic in that the touch becomes rather hard and that yellowing is liable to generate.

Comparative example 7

A knit fabric was prepared in the same manner as in Example 1, except that polyethylene terephthalate fiber of 56 dtex/36f is used as a warp yarn for a front thread guide. The evaluation results are shown in Table 2, from which it is apparent that this knit fabric is soft in touch and free from the yellowing, but unsuitable for an inner wear use due to the generation of grinning.

Comparative example 8

A knit fabric was prepared in the same manner as in Comparative example 5, except that polyethylene terephthalate fiber of 56 dtex/36f is used as a warp yarn for a front thread guide. The results evaluation are shown in Table 2, from which it is apparent that this knit fabric is free from the yellowing and grinning, but unsuitable for an underwear use because the touch thereof becomes hard.

Comparative examples 9 to 13

Knit fabrics were prepared in the same manner as in Example 1, except for changing the runner length. The results evaluation are shown in Table 2, from which it is apparent that these knit fabrics are free from yellowing but are unsuitable for underwear use because of the deterioration of touch and the generation of grinning.

Comparative examples 14 to 18

Knit fabrics were prepared in the same manner as in

Example 12 except for the fabric density <u>at</u> presetting or the runner length. The evaluation results are shown in Tables 2 and 3, from which it is apparent that these knit fabrics are free from yellowing but are unsuitable for underwear use because of the deterioration of touch and the generation of grinning.

Comparative examples 19 to 23

Knit fabrics were prepared in the same manner as in Example 13 except for changing the runner length. The evaluation results are shown in Table 3, from which it is apparent that these knit fabrics are free from yellowing but are unsuitable for underwear use because of the deterioration of touch and the generation of grinning.

Comparative examples 24 to 28

Knit fabrics were prepared in the same manner as in Example 14 except for changing the runner length. The estimated results are shown in Table 3, from which it is apparent that these knit fabrics are free from yellowing but are unsuitable for underwear use, sport wear use or outer wear use because of the deterioration of touch and the generation of grinning defect.

Table 1. Knitting conditions, properties and performances of inventive knit fabrics

		Runner length				Number of courses on machine/ 2.54 cm	Gauge needles/ 2.54 cm	Property				Softness mm	Grinning (grade)	Yellowing (grade)	Transverse elongation %	Heat-moldability	Overall evaluation
		Front No.1 mm	Front No.2	Back No.1 mm	Back No.2			Basis of weight g/m^2	Thickness mm	Courses/ 2.54 cm	Fabric density						
Example	1	1270	-	155	-	80	28	206	0.53	144	6048	102	5	5	129	O	O
	2	1270	-	155	-	80	28	198	0.52	123	5904	98	4	5	141	O	O
	3	1270	-	155	-	80	28	223	0.54	195	6435	120	5	5	120	O	O
	4	1220	-	135	-	80	28	202	0.52	144	4896	113	4	5	118	O	O
	5	1220	-	135	-	80	28	229	0.54	147	7791	122	5	5	140	O	O
	6	1320	-	160	-	80	28	187	0.50	102	4080	105	3	5	127	O	O
	7	1320	-	160	-	80	28	194	0.52	147	5439	110	4	5	125	O	O
	8	1270	-	155	-	80	28	231	0.54	147	6174	121	4	5	117	O	O
	9	1310	-	125	-	70	24	185	0.50	120	4560	101	3	5	126	O	O
	10	1270	-	155	-	80	28	191	0.48	165	6105	109	3	5	126	O	O
	11	1270	-	155	-	80	28	232	0.54	144	6048	113	4	5	128	O	O
	12	950	950	90	90	80	28	163	0.42	195	7800	121	5	5	102	-	O
	13	850	380	70	-	85	28	161	0.44	165	6600	120	4	5	51	-	O
	14	1145	-	120	180	80	28	226	0.54	156	7644	116	5	5	163	-	O

Table 2. Knitting conditions, properties and performance of comparative knit fabrics

		Runner length				Number of courses on machine /2.54 cm	Gauge needles/ 2.54 cm	Property				Softness mm	Grinning (grade)	Yellowing (grade)	Transverse elongation %	Heat-moldability	Overall evaluation
		Front No.1 mm	Front No.2	Back No.1 mm	Back No.2			Basis of weight g/m²	Thickness mm	Courses/ 2.54 cm	Fabric density						
Comparative example	1	1270	-	155	-	80	28	191	0.52	99	4455	116	2	5	133	-	×
	2	1270	-	155	-	80	28	229	0.54	207	7452	129	4	5	119	-	×
	3	1270	-	155	-	80	28	183	0.51	120	3960	101	1	5	111	-	×
	4	1270	-	155	-	80	28	244	0.54	180	8280	138	4	5	138	-	×
	5	1270	-	155	-	80	28	195	0.52	147	6174	108	1	2	101	×	×
	6	1135	-	98	-	91	28	189	0.50	174	7134	125	5	2	90	×	×
	7	1270	-	155	-	80	28	205	0.52	144	5904	114	1	5	103	×	×
	8	1135	-	98	-	91	28	216	0.51	174	7134	134	4	5	88	×	×
	9	1190	-	120	-	80	28	236	0.54	207	7245	129	4	5	113	-	×
	10	1190	-	120	-	80	28	241	0.53	150	8100	136	4	5	127	-	×
	11	1360	-	165	-	80	28	187	0.50	99	5445	117	2	5	142	-	×
	12	1360	-	165	-	80	28	179	0.50	120	3960	104	1	5	119	-	×
	13	1140	-	115	-	80	28	257	0.54	201	8040	132	5	5	112	-	×
	14	950	950	90	90	80	28	165	0.43	210	7350	129	4	5	87	-	×
	15	950	950	90	90	80	28	172	0.44	195	8775	139	3	5	107	-	×
	16	1150	1150	105	105	80	28	148	0.41	96	4320	111	1	5	123	-	×

Table 3. Knitting conditions, properties and performances of comparative knit fabrics

		Runner length				Number of courses on machine /2.54 cm	Gauge needles/ 2.54 cm	Property				Softness mm	Grinning (grade)	Yellowing (grade)	Transverse elongation %	Heat-moldability	Overall evaluations
		Front No.1 mm	Front No.2	Back No.1 mm	Back No.2			Basis of weight g/m^2	Thickness mm	Courses/ 2.54 cm	Fabric density						
Comparative example	17	1150	1150	105	105	80	28	140	0.38	120	3840	104	1	5	84	-	×
	18	925	925	90	90	80	28	170	0.48	210	8400	134	5	5	93	-	×
	19	750	400	75	-	90	28	168	0.47	204	7752	126	3	5	55	-	×
	20	750	400	75	-	90	28	176	0.48	165	8250	133	3	5	66	-	×
	21	850	420	80	-	90	28	151	0.39	96	4320	101	1	5	61	-	×
	22	850	420	80	-	90	28	148	0.40	120	3840	102	1	5	41	-	×
	23	825	350	70	-	90	28	172	0.48	207	8280	131	3	5	82	-	×
	24	1145	-	120	160	80	28	230	0.56	204	7956	129	5	5	144	-	×
	25	1145	-	100	160	80	28	239	0.58	165	8415	137	5	5	164	-	×
	26	1200	-	100	200	80	28	192	0.47	96	4320	108	1	5	137	-	×
	27	1200	-	150	200	80	28	187	0.47	123	3813	102	1	5	98	-	×
	28	1145	-	150	160	80	28	246	0.61	204	9180	143	4	5	149	-	×

CAPABILITY OF UTILIZATION IN INDUSTRY

The stretchable raschel-type warp knit fabric according to the present invention is free from yellowing, is soft in touch as well as being free from generation of grinning, and has a unique surface feel, not obtainable from a knit fabric including nylon fiber. Since the stretchable raschel-type warp knit fabric according to the present invention is excellent in heat-moldability, it is suitably used for underwear such as foundation wear, sports wear, such as a swim suits, or outer wear.